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(54) FRAMED FILTER ELEMENT AND PROCESS FOR ITS PREPARATION

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SUBSTITUTE

REMPLACEMENT

SECTION is not Present

Cette Section est Absente

This invention relates to plastics frame filter elements in which the filter material is supported in a tensioned condition by the frame and penetrates through at least one side of the frame to such a distance that the projecting filter material can serve as a seal, and the frame itself airtightly penetrates through the filter medium.

Various kinds of planar filter elements are known which usually consist of the filter material and an appertaining frame. The frames containing the filter material can then be screwed together to form large area filters, or be inserted into corresponding holder devices in which, for example, a plurality of frame filters can then be disposed in a V-arrangement. The planar filters of the prior art have in particular the disadvantage that the filter medium is not in a sufficiently stretched condition in the frame, so that, despite the provision of additional longitudinal and transverse struts between which the filter material is inserted, relatively pronounced vibrations of the filter medium may occur during use. These vibrations allow some of the tiny particles which are to be filtered out, to be "knocked through" the filter material. Moreover, in filter installations of this kind serious problems inevitably arise in respect of the sealing between the individual frames on the one hand and between the frames and the holder device on the other hand. Similar disadvantages are also found in framed filters of other shapes in which the filter medium is located in corresponding frames.

The present invention seeks, therefore, to provide a solution to manufacturing a filter which does not have the above mentioned disadvantages of known such filters, and which can in particular be easily manufactured.

According to the present invention there is provided a filter element consisting of a porous filter material and a frame, characterised in that:

(a) the filter material has at a distance from its edges a frame of plastics material passing through the filter material, the plastics frame and the filter material forming a unit impermeable to air;

(b) the filter material projects out of at least one side of the frame to such an extent that the projecting filter material serves as a seal;

(c) the filter material is held under tension in the frame, and

(d) the filter material and the frame are additionally connected by longitudinal and transverse struts of plastics material which homogeneously penetrate through the filter material towards both sides and form a homogeneous unit with the frame.

By virtue of the fact that the plastics material is in a flowable condition during the production of the frame or of the longitudinal and transverse struts, it is possible for the plastics material to penetrate through the filter material from both sides and in this way form a one-piece frame or one-piece longitudinal and transverse struts in which the filter medium is firmly enclosed.

The filter material is preferably framed in such a manner that the filter material penetrates through the frame towards the outside on all sides. The preferably flexible filter material projecting through the frame then serves, for example, as a seal when the frame filters are inserted into corresponding holder devices or when individual frame filters are joined together to form a large area filter.

Flexible filter materials, that is to say materials which are flexible, elastic, or pliable, consist, for example, of fleeces.

The same effect can however also be achieved with rigid filter material, such as perforated metal sheets, if the edges of the rigid filter material, together with a flexible sealing medium in strip form, which for example projects out of the frame towards the outside on at least one side, preferably on all sides, are embedded in the plastics material.

The filter medium used in each particular case is clamped in suitable tools, which are familiar to the specialist, under a determined pre-tension and then provided with the frame and the longitudinal and transverse struts. In this way, it is possible to obtain a completed filter element having a tautly stretched filter material in which inter alia the vibration effects mentioned above which otherwise would occur in use, are practically eliminated.

For further strengthening of the frame or longitudinal or transverse struts which may be provided across the frame, it is possible during their manufacture to embed wire or other such strengthening materials into the plastics material together with the filter material and, if appropriate, the sealing strip. This will be necessary only in certain cases, however, since the filter material itself functions as a strengthening inlay.

For some applications of the filter elements according to the invention, it may be necessary, if the frames are to be inserted into existing frame supports, for these to be of a thickness which is determined by the frame supports

and which may be, therefore, of a thickness which would otherwise be unnecessary. In such a case, it is not necessary to make the entire frame so thick but it may be adequate to provide the required thickness at certain intervals with so-called spacer projections. Furthermore, the frames and the longitudinal or transverse struts may be relatively narrow, so that the effective useful area of the filter element is larger than with previously known framed filter element of the same overall dimensions. Furthermore, it is possible for both the frame and also the longitudinal or transverse struts to have any desired cross sectional shape.

One embodiment of the invention comprises a web of filter medium on which there are at least two supporting frames with longitudinal and/or transverse struts, the frames being disposed adjacent one another along the length of the web of filter material and spaced at such a distance from each other in relation to the thickness of the frame members that the filter element can be folded through an angle in the region of 180°.

The filter elements of the present invention may be flat, or may have the form of at least part of a cube, a sphere, a cone, a truncated cone or cylinder provided with a frame adjacent the or each edge. The frame or frames may include longitudinal and/or transverse struts. It should be mentioned that where such filters are concerned previously known arrangements have required the frame to be stitched or glued on and the filter to be held in shape by sewn-in metal rods, metal rings or metal grids. It will be appreciated that shapes other than those listed above can be formed as embodiments of the present invention.

In the case of very finely perforated metal plates, in which the perforation is made for example by means of electron beams, or in the case of other corresponding rigid filter materials it may be of advantage if the edges of the filter materials are provided with relatively large holes prior to embedding in the plastics material so that a continuous firm cohesion is provided between the underside and the upper side of the plastics material frame. This technique can also be used, if desired, in the case of flexible filter media.

For certain applications it may be preferable if the frame is formed of a flexible plastics material while the longitudinal or transverse struts are formed or a rigid plastics material. If a rigid frame is provided it may have a flexible sealing material applied thereto, for example by adhesion or by being foamed on directly. In this case, the flexible material may provide a sealing function between the frame and a frame support. Preferably, however, a flexible filter material is used with a rigid frame in which the filter material projects outwardly from the frame to provide a sealing strip around the outer edge.

In the embodiment of the invention utilising a web of filter material the longitudinal edges of the web may be embedded in a flexible plastics material, preferably consisting of an elastic cellular polyurethane such as the cellular polyurethane elastomer material sold under the trade name Cellasto by Lemforder Kunststoff GmbH. Such elongate filter elements are used, for example, in filter assemblies in which the filter element is fed from a supply roll located above the filtering position. In

general these filter assemblies consist of an upper roller and a lower roller, two lateral U-section guide rails and a supporting grid. The filter material is laterally supported by the U-shaped rails and is supported at one side, by the supporting grid.

The frames and the longitudinal and transverse struts may be made of any synthetic plastics material which can be converted to a flowable condition, such as the thermoplastic synthetic materials; examples of suitable materials are polyvinyl chloride, vinylchloride copolymers, polyethylene, polypropylene, polystyrene, polyvinyl carbazole, polyisobutylene, polymethacrylate, polyvinylidene chloride, polytetrafluoroethylene, polyacrylonitrile, polyoxymethylene, polyethylene terephthalate, linear saturated polyester resins, polyamides, polycarbonate, linear polyurethanes, and the various thermoplastically processable cellulose derivatives. Preferably, the thermoplastics materials are used in conjunction with corresponding propellants, in order to obtain foamed frames or longitudinal and transverse struts which have a particularly light weight with respect to previously known frames.

Embedding the filter material in such thermoplastic materials can be carried out in co-operating heatable tools, in which the plastics material is plasticised and pressed against the filter medium, or alternatively by the application of injection moulding techniques.

Moulding resins also can be used advantageously for producing the frames or longitudinal and transverse struts. These moulding resins, which can consist of polymerisable

monomers or corresponding liquid prepolymers are introduced into a tool, in which the filter medium is already located, together with hardeners. After a certain time, these products then harden, forming solid plastics material. Examples of these are epoxy or polyster based resins.

For producing the frames and the longitudinal and transverse struts, however, polyurethane and the techniques associated therewith are particularly suitable and both rigid or flexible polyurethanes can be used. These may be foamed or not, as desired. Preferably, a foaming polyurethane is used, the polyurethane being injected into the mould in which the filter material to be framed has previously been laid or clamped. After injection at one or more places, the polyurethane foam expands and its own foaming pressure fills up the mould, whereupon it completely and homogeneously penetrates and foams in or around the filter material.

If, for example, it is desired to manufacture a frame which is intended to have high torsion resistance, then preferably a duromer integral foam is chosen with a relatively high density, for example, between 300 and 800 kg/cu.m, to produce a high strength in the end product (further details will be found in: Bayer-Werk, Leverkusen, Baydur-System, Polyurethane- Integral- Foam rig, provisional product Bulletin of 1st October, 1969; Kunstostoff-Handbuch, Vol. VII, Polyurethane, pp.504 et seq., Hanser-Verlag, Munich).

However, frames and longitudinal and transverse struts can also be made from foams which have a far lower density,

for example, flexible or rigid polyurethane foam with densities between 60 and 300 kg/cu.m.

The foam can also be chosen with reference to its fire resistance, so that fire risk can be taken into account.

The frame or frames and, if appropriate, the longitudinal and/or transverse struts produced in the above-described manner are well connected to the filter material and thus form a suitably strong bond therewith.

Suitable filter materials for use in embodiments of this invention can be divided into four broad groups, namely:-

a) metals, for example braided or woven metal threads or metal wool;

b) filter cloths, filter fabrics, filter gauze or filter felts;

c) filter fleeces (stretched or chopped strand fleeces); and

d) open-pore foamed substances.

The filter cloths, filter fabrics, filter gauzes, filter felts and filter fleeces may consist of vegetable, animal, mineral or synthetic fibres, or may be produced from mixtures thereof.

Filter elements formed as embodiments of the invention may be used, for example, as air filters, liquid filters or separating filters.

Any form of permeable material can be provided with a supporting frame, even impermeable material, e.g. ceramic or sintered glass materials, can be provided with such a frame if a suitable row of holes is first provided where

the frame is to be formed. In this way, it is possible, for example even to frame material which is to be used as wall or ceiling decorations. In this case, the frame can have press-stud shaped projections which make it possible to secure the material to a wall or ceiling by means of the frame, in a readily removable manner. Similarly, woven or non-woven laminar structures can be provided with a frame. Even flat foil heating elements can be framed in this way.

According to another aspect of the invention there is provided a method of manufacturing a filter element as defined above comprising the steps of clamping a selected filter material in a suitable tool and then introducing a mixture of polyurethane starting components and corresponding additives to produce an integral foam through one or more inlet apertures into the tool and allowing them to react in the tool while maintaining the conditions necessary to produce the integral foam.

Various embodiments of the invention will be more particularly described by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates a first embodiment of the invention, in which the frame is formed slightly displaced from the edge of the permeable material;

Figure 2 shows in cross-section a filter element of Fig. 1 in a holder, the filter material projecting through the frame serving as a seal;

Figure 3 is a cross section of a portion of a filter element during the process in which a frame with transverse and longitudinal struts is being formed thereon;

Figure 4 is a plan view of a filter element produced by the mould of Fig. 3;

Figures 5, 5a and 5b illustrate an embodiment of the invention having a cylindrical piece of filter material, and a moulding tool for forming a supporting frame therefor;

Figure 6 is a plan view of a further embodiment of the invention comprising an elongate web of material having a plurality of support frames formed thereon;

Figure 7 is a side view of the embodiment of Figure 6 folded into a zig-zag configuration;

Figures 8 and 9 illustrate an embodiment of the invention having spacer projections;

Figures 10 and 11 illustrate an alternative form of sealing between two adjacent frames;

Figure 12 shows a bank of stacked filter elements;

Figures 13 and 13a illustrate a two part frame structure; and

Figures 14 and 14a illustrate the mounting of a cylindrical embodiment of a filter element in a mounting panel.

Referring now to the drawings, in Figure 1 there is shown an embodiment of the invention in which a frame 1 is formed respectively adjacent and actually surrounding the edge of a sheet of permeable material 2. The protruding edge 6 of the filter material 2 in Fig. 1 serves as a seal or packing.

Figure 2 illustrates how a frame 1 having the projecting sealing strip 6 of filter material can be sealed against either a side wall 13 or a frame support 14.

In Figure 3 there is shown a mould comprising a lower

shell 4 over which a filter material 2 is laid. The filter material 2 is pre-tensioned at the sides by clamping over a lower shell of a mould. The lower shell 4 of the mould has recesses formed therein, which correspond respectively to the shape of the frame 1 and transverse and longitudinal struts 5. An upper shell 3 of the mould, which has recesses which may or may not be mirror images of those on the lower shell 4 of the mould is pressed down onto the lower shell of the mould to exert a predetermined pressure on the filter material 2.

At one or at a plurality of locations, the mould has insertion points, through which the plastics material to be introduced can be injected under the required high pressure. The reaction mixture inserted into the mould, as it develops a foaming pressure, fills up the cavities in the mould and at the same time penetrates into the filter material 2. After a time (depending on the particular materials used) the mould is opened and the filter provided with the frame 1 and struts 5 thus formed can be removed (Fig. 4). The filter medium 2 can be so clamped in the mould that it projects through the cast or foamed frame on all sides to form the sealing strip 6 (see Figs. 1 and 4).

The cross section of the recesses in the two parts of the mould may be any desired suitable shape in addition to that shown. Similarly, it is possible to mould the frame 1 and the longitudinal and transverse struts 5 from rigid plastics material. On the other hand, it is also possible for the frame 1 to consist of a flexible foaming material while the longitudinal and transverse struts 5 consist of rigid plastics material. Furthermore, it is

possible in a first stage in a first mould to provide the filter material 2 with a more or less rigid frame 1 and, in a second operation, in a second mould, to foam a flexible foaming plastics material onto the rigid frame. Similarly, several sheets of filter material 2 can be clamped jointly in one frame 1 and spaced apart as desired.

If filter materials in the form of tubes, cylinders, cones or truncated cones are to be framed, then in principle the same above-described procedure will be used. For example, as shown in Figures 5, 5a, 5b, the filter material 9 to be framed will be placed on an inner core 8 and the two mould halves 7 will be moved into position over the filter material to grip the core 8; the two mould halves 7 are then pressed together at a predetermined pressure and the frame material 10,11 foamed into place. If required, a plurality of annular frames 10 can be formed, each connected to longitudinal struts 11.

In the embodiment shown in Figure 6 a web 12 of filter material 2 is provided with several frames 1 having transverse and longitudinal struts 5. The frames 1 are spaced slightly from one another and may be formed individually in succession by moving the web stepwise through the mould, or several frames may be formed simultaneously on the web by means of a plurality of serially disposed moulds.

A web 12 of filter material having a plurality of frames as shown in Fig. 6 can then be placed in zig-zag arrangement, as shown in Figure 7, in a larger frame support (not shown) so that part of the filter material 2 which also functions to connect adjacent frames also being used as a filter surface.

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The embodiment shown in Figures 8 and 9 comprises a frame 1 which is foamed in a standard thickness H but which, by simple sanding down or cutting off of parts of space projections 13, can be adapted to any thickness of frame required by the frame supports. In this embodiment the filter material 2 projects through the frame 1 to form the seal 6.

Figures 10 and 11 illustrate the use of two or more frames having projecting sealing strips 6 of the filter material which are mutually sealed simply by abutting the two sealing edges 6.

In the embodiment shown in Figure 12 the frames 19 are formed with co-operating upper and lower grooves and ridges 20 which assist in forming a stack of filter elements in a U-shaped holder 18. The filter elements 2a, 2b, 2c may be identical or may be formed of different filter materials.

Figures 13 and 13a illustrate a filter element frame having a rigid part 1 and a flexible part 22.

Figure 14 illustrates a filter element shaped into a cylinder having a frame member 23 (and struts 11) with a screw thread by means of which the element can be screwed into a panel 21.

Figure 14a illustrate a filter element having a shaped annular frame member 24 (with struts 11) by means of which the element is mounted in a panel 21 and held in place by a clamping plate 26 and annular spacer 25.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A filter element consisting of a porous filter material and a frame, characterised in that:

(a) the filter material has at a distance from its edges a frame of plastics material passing through the filter material, the plastics frame and the filter material forming a unit impermeable to air;

(b) the filter material projects out of at least one side of the frame to such an extent that the projecting filter material serves as a seal;

(c) the filter material is held under tension in the frame, and

(d) the filter material and the frame are additionally connected by longitudinal and transverse struts of plastics material which homogeneously penetrate through the filter material towards both sides and form a homogeneous unit with the frame.

2. A filter element as claimed in claim 1,wherein the filter material projects out of the frame on all sides so as to form the seal.

3. A filter element as claimed in claim 1, wherein the longitudinal and transverse struts are made of the same material as the frame and are produced in the same manufacturing operation.

4. A filter element as claimed in claim 1, comprising a web of filter material on which there are at least two supporting frames with longitudinal and/or transverse struts, the frames being disposed adjacent one another along the length of the web of filter material and spaced at such a

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distance from each other in relation to the thickness of the frame members that the filter element can be folded through an angle in the region of 180°.

5. A filter element as claimed in claim 1, claim 2 or claim 3, in which the filter material is in the form of part of either a cube, or a sphere, or a cylinder, or a tube, or a cone, or a truncated cone and the, or at least one, edge thereof is inserted in a correspondingly shaped supporting frame.

6. A filter element as claimed in claim 1, claim 2 or claim 3, in which there are additional strengthening members embedded in the said plastics material frame in which the filter material is embedded.

7. A filter element as claimed in claim 4, in which the plastics material of the frame and/or the longitudinal struts and/or the transverse struts is a rigid and/or a flexible plastics material.

8. A filter element as claimed in claim 1, claim 2 or claim 3 in which the frame is provided with spacer projections.

9. A filter element as claimed in claim 1, in which the frame and/or the struts is or are formed of a foamed or non-foamed thermoplastics synthetic material or such foamed or non-foamed synthetic plastic materials as have been formed during shaping by molecule enlargement from monomeric or corresponding preproducts.

10. A filter element as claimed in claim 9, in which the frame and/or the struts is or are formed of a polyurethane integral foam.

11. A method of manufacturing a filter element as claimed in claim 1, claim 2 or claim 3, comprising the steps of clamping a selected material in a suitable tool and then injecting under pressure a mixture of polyurethane starting components and corresponding additives to produce an integral foam through one or more inlet apertures into the tool and allowing them to react while maintaining the conditions necessary to produce the integral foam.

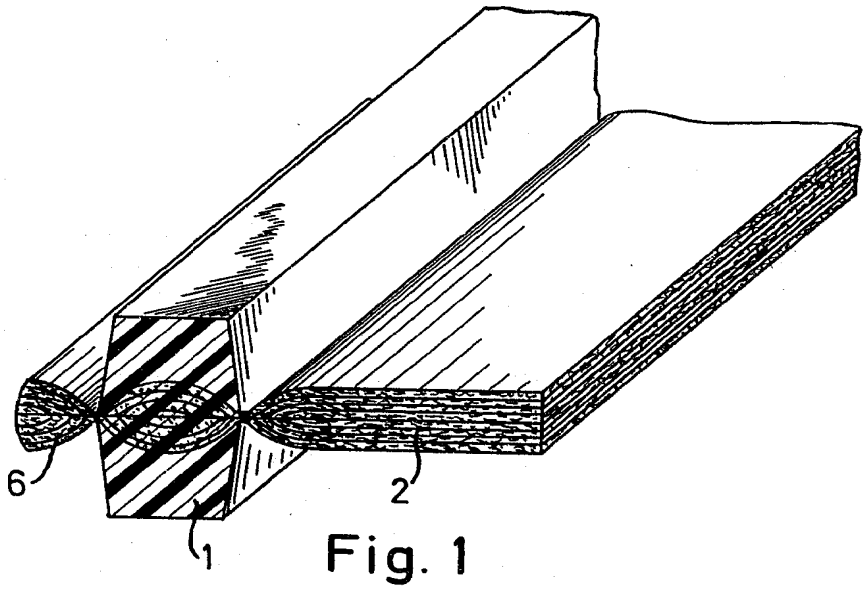

Fig. 1

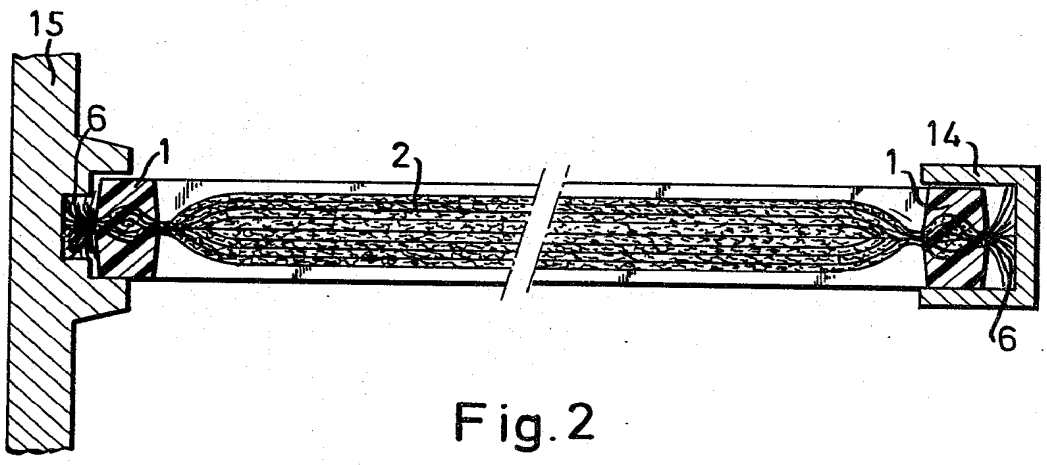

Fig. 2

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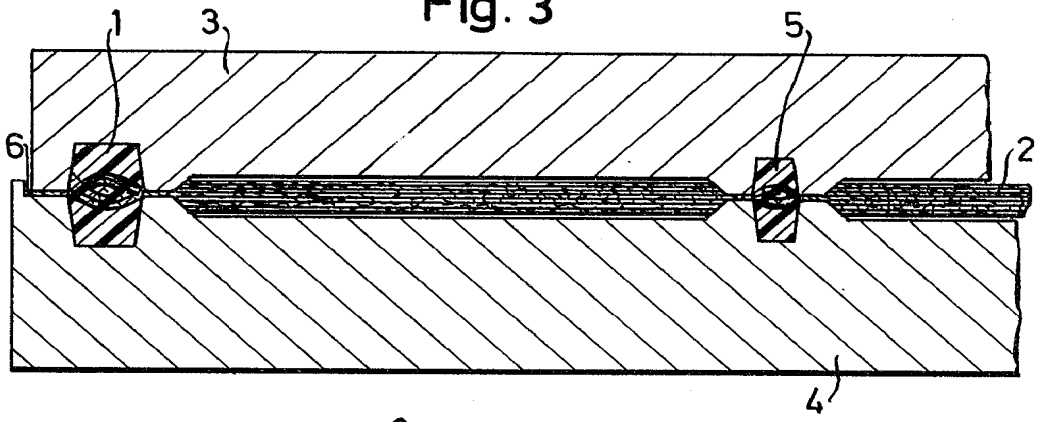
Fig. 3



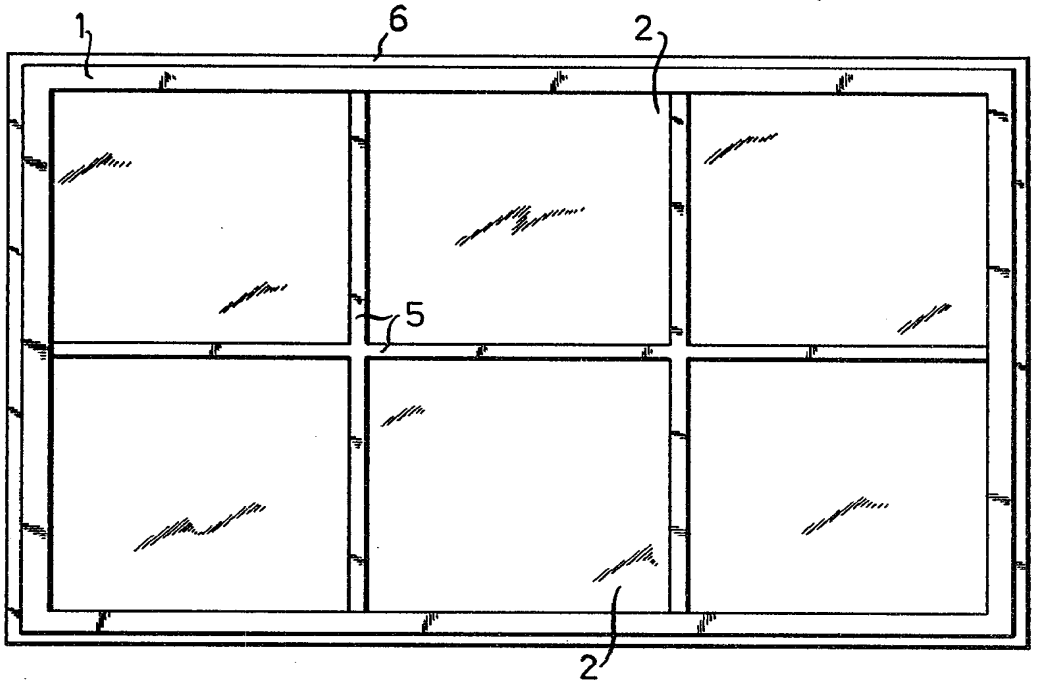


Fig. 4

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Fig. 5

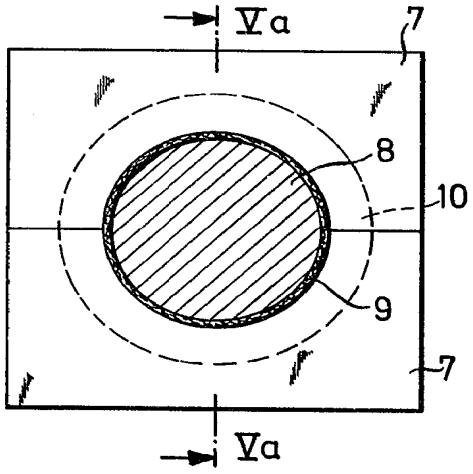


Fig. 5a

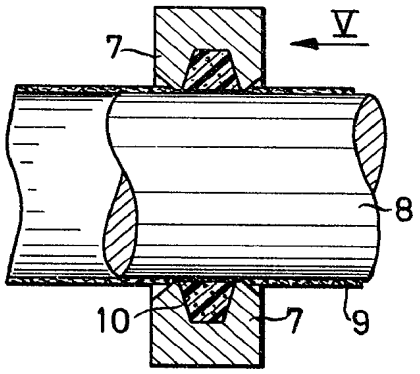
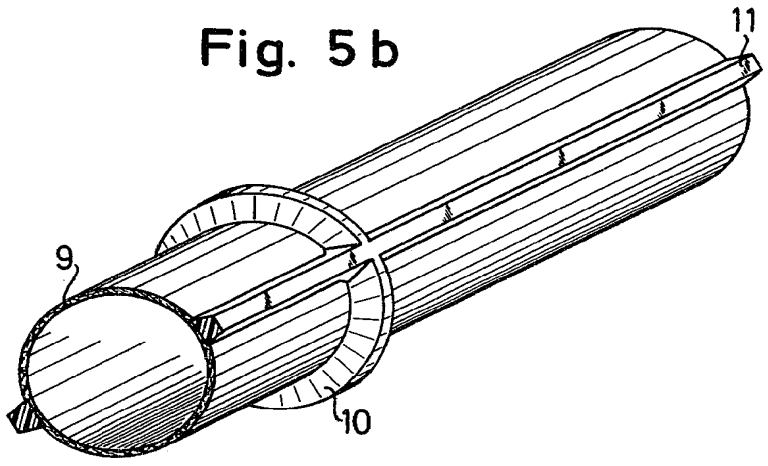


Fig. 5b



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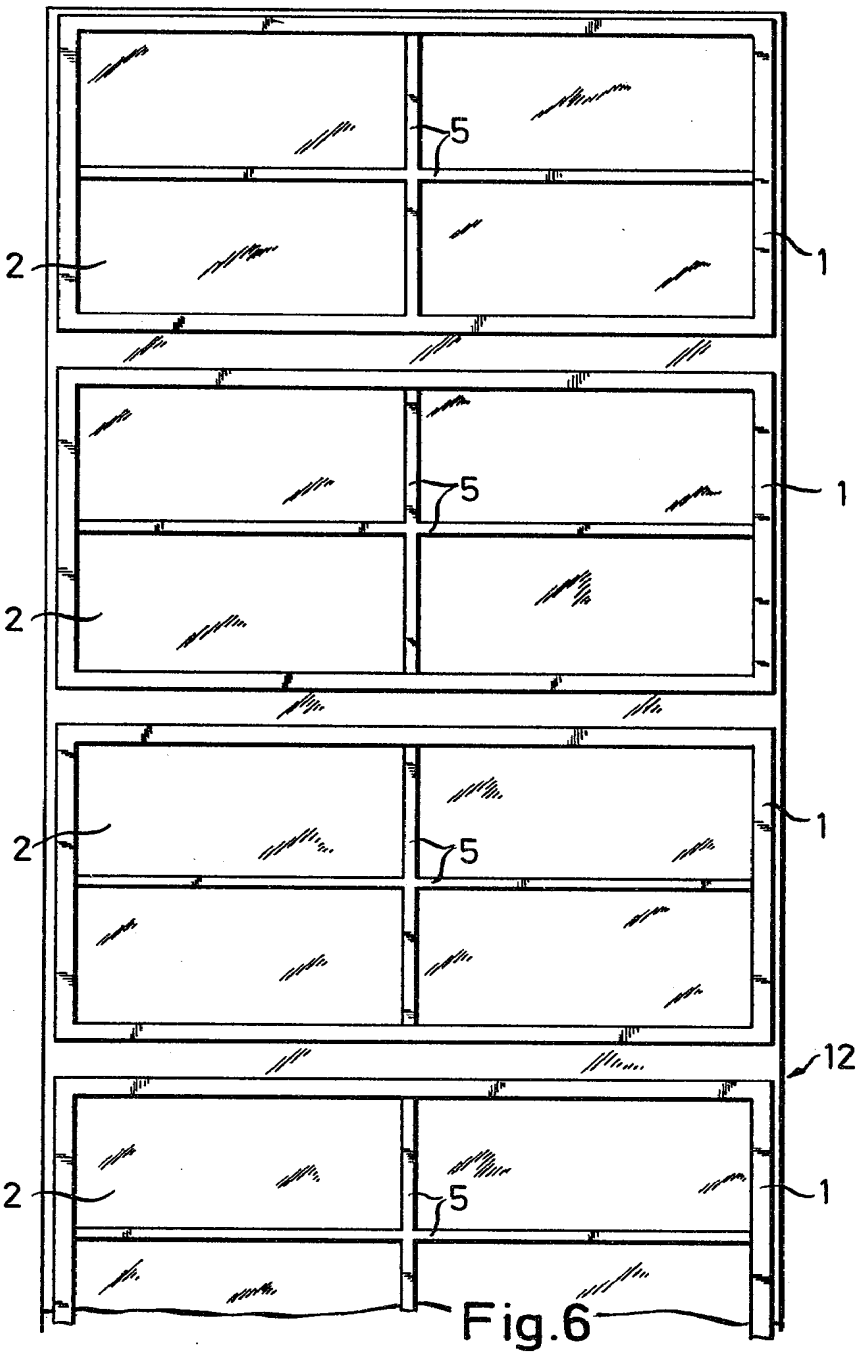

Fig.6

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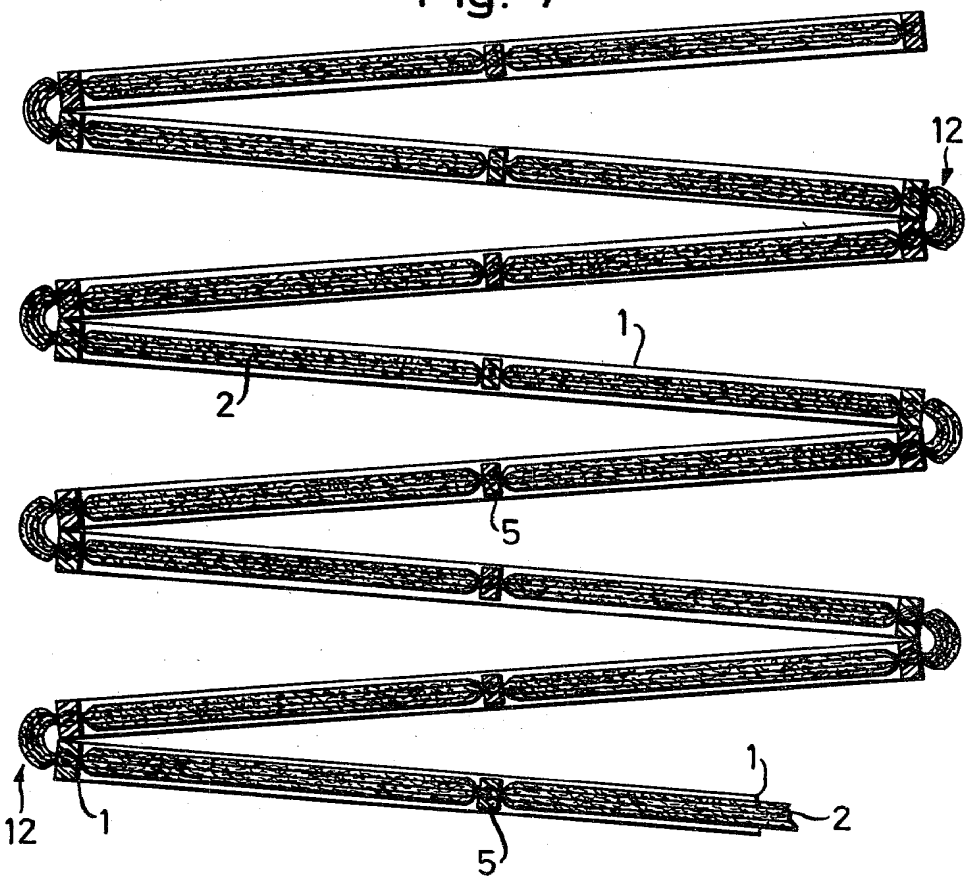
Fig. 7



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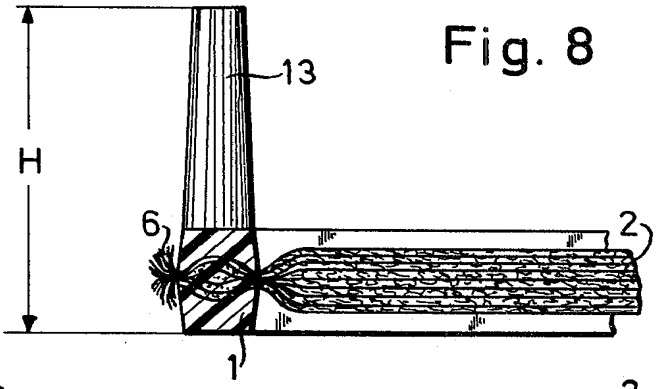

Fig. 8

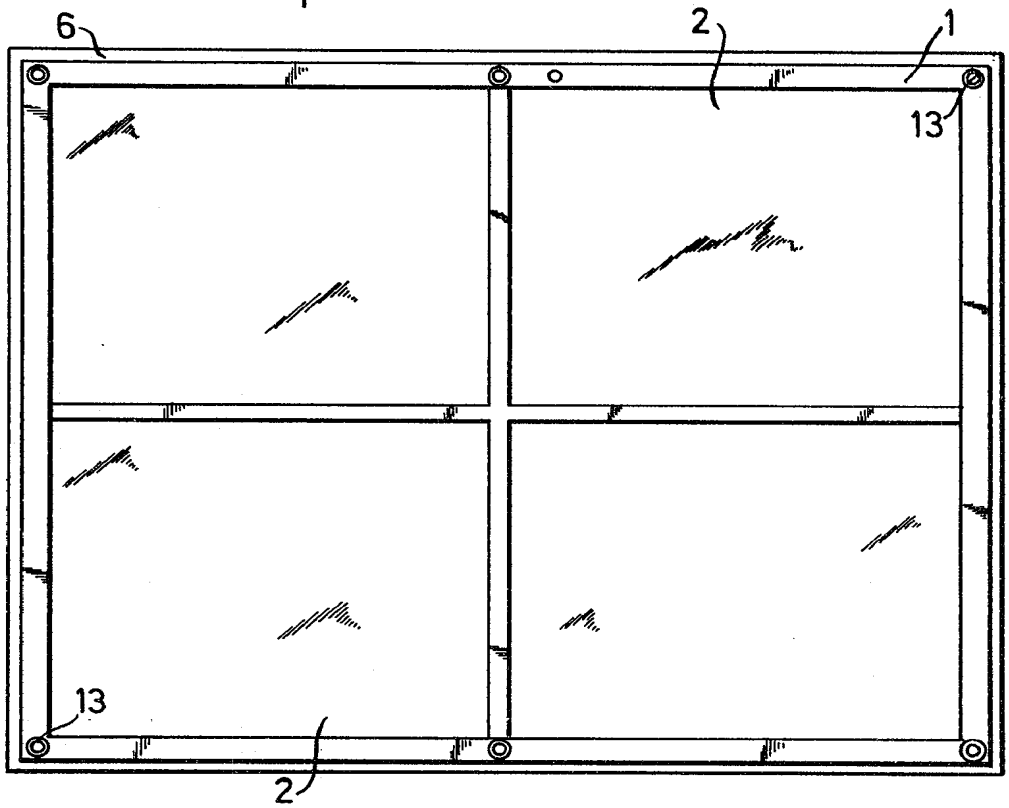

Fig. 9

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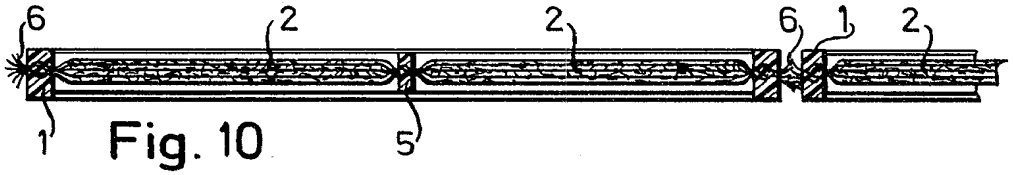

Fig. 10

Fig. 11

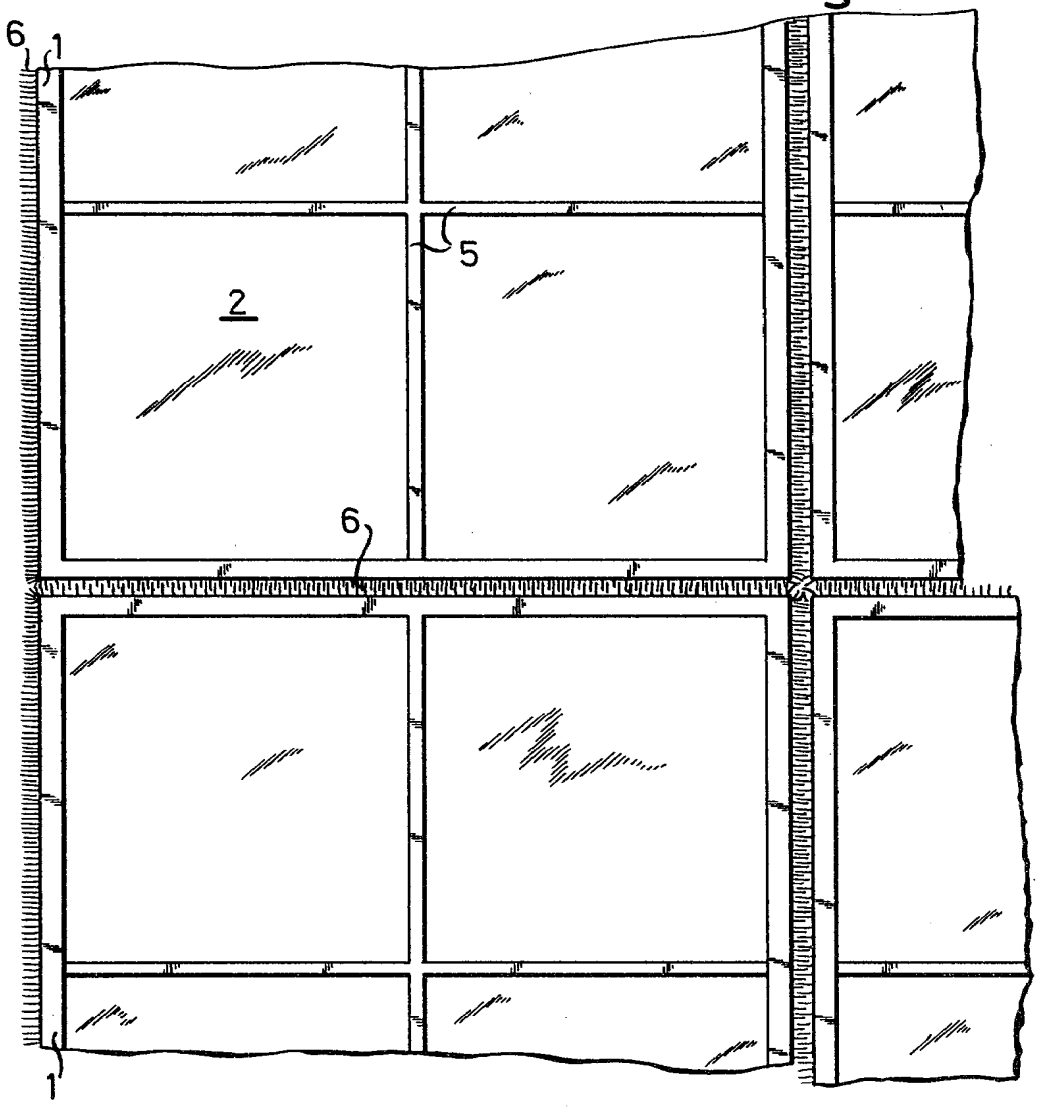

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Fig. 12

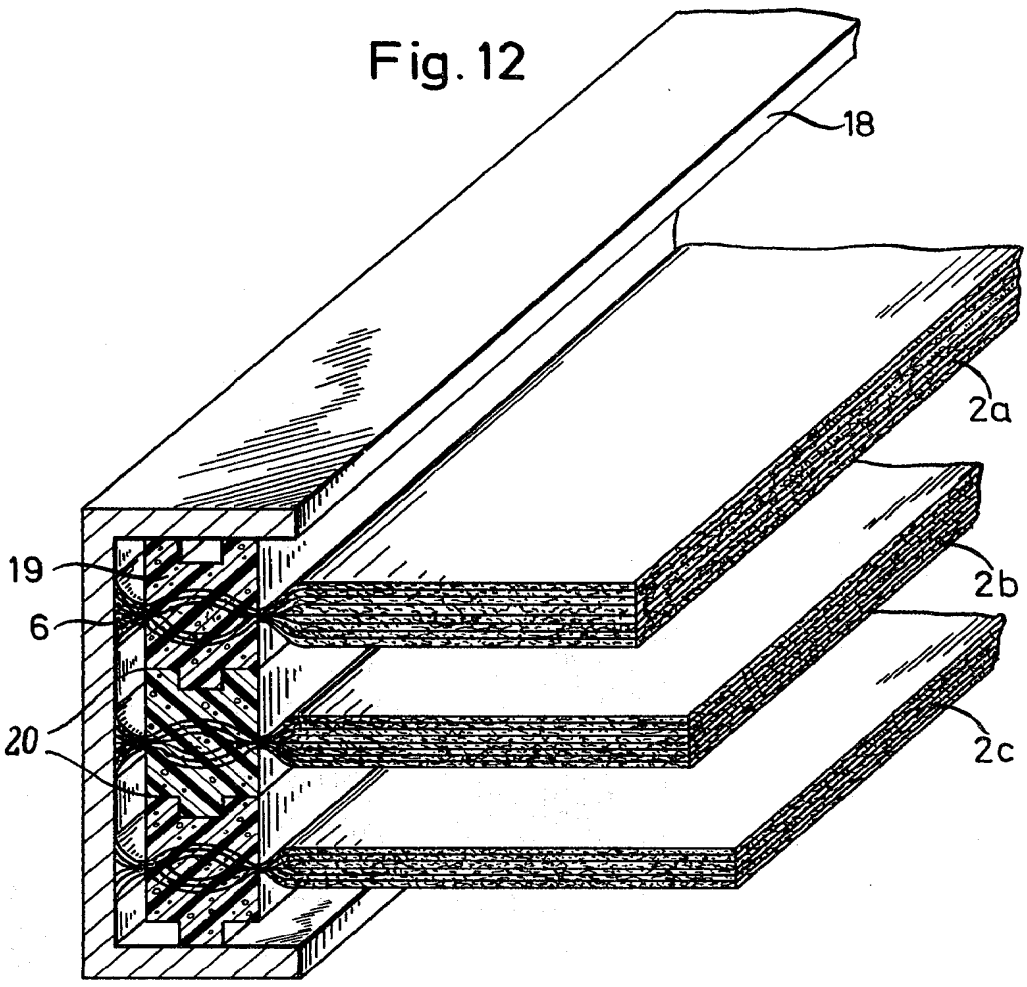

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Fig. 13

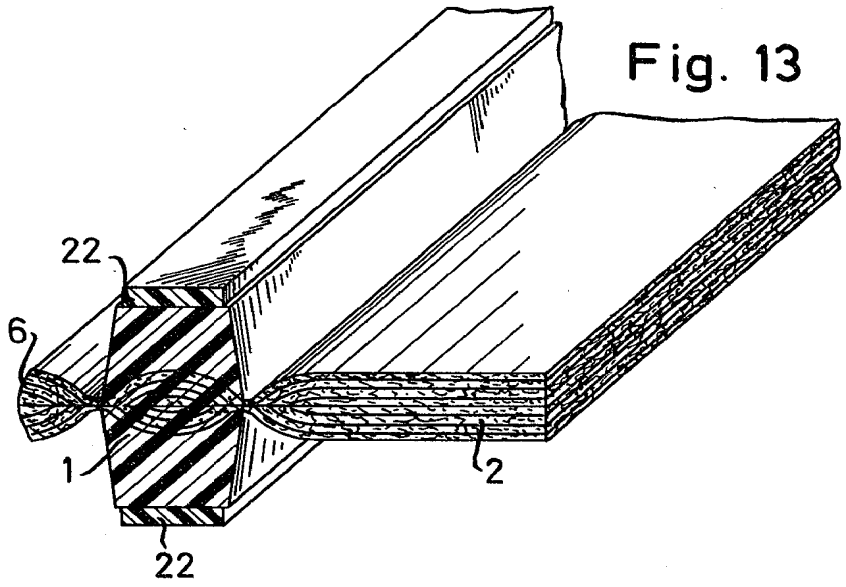
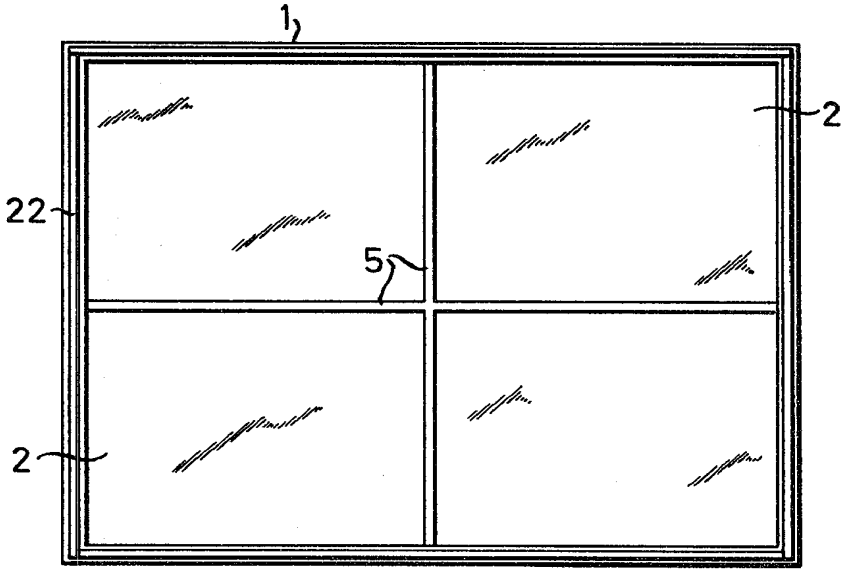


Fig. 13a



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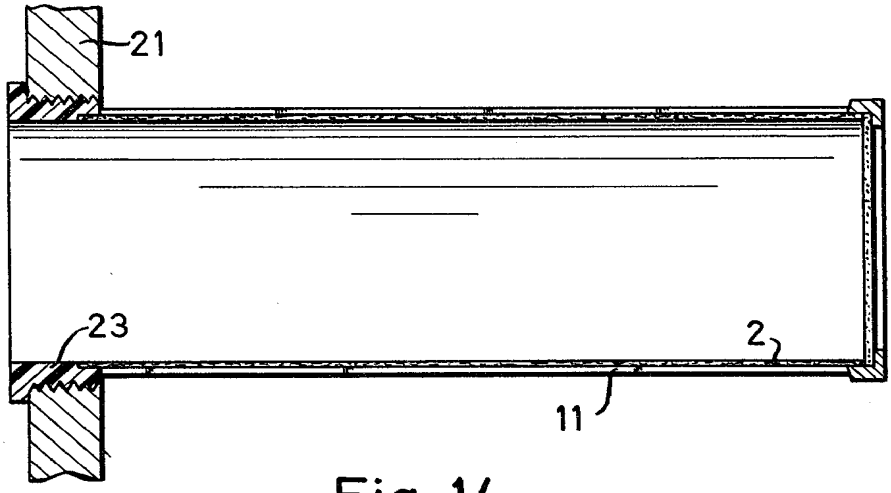

Fig. 14

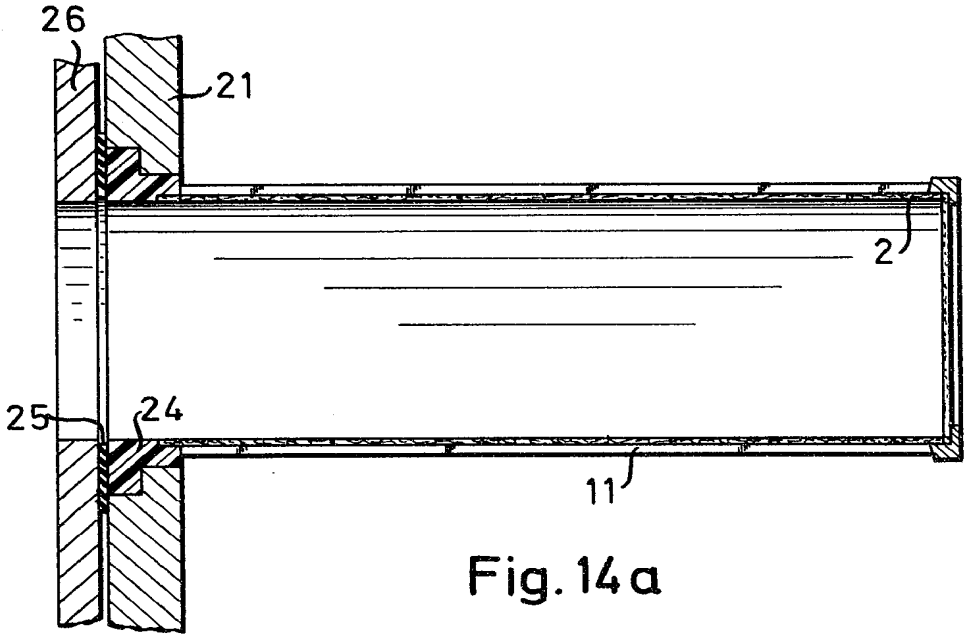

Fig. 14a

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